No. 31 February-March 1990

solplan review

the independent newsletter of energy conservation, building science & construction practice

Inside . . . . .

Peeling paint problems on siding have been around for a long time. Recently there seems to have been an increase in the number of cases, especially as older houses have been upgraded with insulation blown into the walls. A study was done to determine what the source of the problem was. Joe Lstiburek reports on on the study and what was found. The lessons to be learned from this study apply to new construction as well as to renovations, as they can contribute to a longer life span of the houses.

The use of mid-efficiency induced draft furnaces has increased. It has been assumed these furances are safer than naturally aspirating furnaces when a house is placed under a negative pressure, as happens often.

A study by Sheltair Sceintific has uncovered that up to now no one has looked at just how much depressurization these units can tolerate. We present the findings.

The CHBA-TRC is an important clearing house for research and development activities in the Canadian home building industry. We introduce the TRC, and bring a message from Willis Graham, the Committee Chairman.

Other items include a report on chimney performance tests, a handbook on radon mitigation, an ADA course, information on design for the handicapped, and index to past issues of Solplan Review.

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Paint Failure in siding

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Richard Kadulski

From the Publisher

We have come to value the importance of research in all walks of life. It not only allows us to keep on top of developments, but also to make better use of precious resources, to provide better more efficient products, and to avoid or minimize problems caused by our activities.

R&D has brought us not only the marvels of technology such as the computer and FAX machine, but also more lowly but equally important products like finger jointed studs, composite beams and joists, high efficiency mechanical equipment, not to mention tools like the nailing guns that improve productivity.

It is not just important to stay on top of new developments. We must be actively involved. Politicians have stressed the need for R&D and promised their support; as recently as last summer the Prime Minister was promising to give it a higher priority.

So what is the government doing? Just before Christmas Treasury Board President Robert de Cotret announced a program to save $1.4 billion over the next three years. The reductions include a $.5 million decrease to the administrative budget of the Canada Mortgage and Housing Corporation (CMHC) and a $3 million reduction in research expenditures (this is being written before the budget, other cuts may make these look like a drop in the bucket; who knows how much more is going to be cut).

Last year CMHC received special recognition from the Auditor General for its achievements in setting a standard for cost effectiveness, efficiency and fiscal accountability, so these reductions come out of the blue. The announcement seems to be unfair and totally unwarranted.

CMHC sponsored research is vital to the building industry. Our industry does not have many players with the necessary resources to put into the basic research. Corporations usually only want to know about practical product related research; if they do basic research they keep it to themselves to avoid embarrassment or to protect their competitive edge.

We must keep in mind that a building is a whole system made up of many different parts. By putting them together we get something much more significant. How these different parts interact together involves many basic principles that need to be defined, analyzed .

Yes, how limited resources are allocated is a case of priorities, but R&D must be considered an investment in the future. When you are running low on fuel, you don't chop up you house to keep you warm, or you're not going to have much house for very long. Cutting back on R&D is the same.

Richard Kadulski
Publisher

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the independent newsletter of energy conservation, building science & construction practice

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SOLPLAN REVIEW is published 6 times per year by:
the drawing-room graphic services ltd.
Box 86627, North Vancouver, B.C. V7L 4L2
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Street address:
205-1930 West Broadway
Vancouver, B.C. V6J 1Z2

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ISSN: 0828-6574

SUBSCRIPTIONS: $30.00 per year.
U.S.A. and other foreign subscriptions payable in U.S. funds or $36.00 Canadian.

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Printed in Canada
Second Class Mail Registration No. 6855
Postage paid in Vancouver, B.C.

Date of Issue: February 1990

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energy efficient building consulting services
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HOT2000 analysis

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Paint and Siding Failures Due to Insulation

Joseph Lstiburek

Peeling paint problems on wood siding have been around for a long time. complaints have increased recently, especially in homes that have had blown insulation installed in their sidewalls within the past two years. The problems are not insulation specific, but occurred with different types of insulation: cellulose, fibreglass, tripolymer foam, etc. Blown cellulose was singled out, but it was unclear whether this was because of the specific properties which made cellulose unique or because more sidewalls were being blown with cellulose than any other kind of blown insulation.

Even more recently, complaints began to appear about peeling paint and wood siding failures on new houses where wood siding had been installed over foil-faced isocyanurate and extruded polystyrene insulating sheathing. Not only did paint peel, but wood siding was cupping, warping, splitting and actually falling off walls. The siding manufacturers blamed the insulating sheathing manufacturers, and the insulating sheathing manufacturers blamed both the siding manufacturers for poor quality siding and the builders for not nailing the siding on properly. Committees were struck, a consensus was reached, and of course the poor builders were ultimately blamed. Recommendations were issued, but it was unclear which recommendations, if any, worked or why.

Yet there were thousands of older houses with blown insulation with no problems as well as thousands of new houses with insulating sheathing with no problems. Why were some houses experiencing failures and not other?

In a survey of 150 houses, 5 types of problem situations were noted.

1. Houses which experienced extensive peeling and blistering of paint on the exterior of the south and west elevations, within two years of blowing the sidewalls full of insulation. These houses were typically 15 to 30 years old and had no siding problems before.

2. Houses which experienced extensive peeling paint on the interior surface of the south walls, within two years of blowing the sidewalls full of insulation. These houses were typically 50 to 60 years old and had no siding problems or interior paint peeling problems previously.

3. Houses which had minor peeling and blistering paint on the exterior of the north and east elevations within two years of blowing the sidewalls full of insulation. These houses were typically 20 to 40 years old and had experienced no siding problems previously.

4. Houses which had no siding or paint problems on the exterior or interior of any elevations before or after blowing the sidewalls full of insulation. These houses were typically 30 to 50 years old or older.

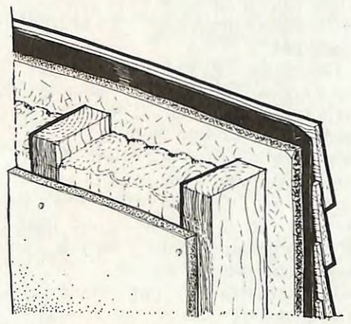


Figure 1: *Type 1 wall assembly: siding over asphalt building paper, ½" asphalt fiberboard, 2x4 studs, gypsum board*

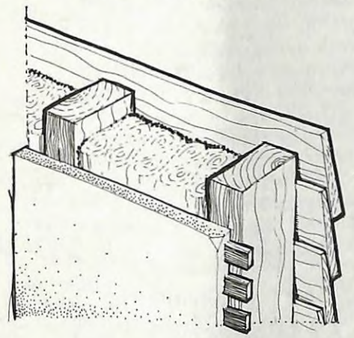


Figure 2: *Type 2 wall assembly: wood siding directly on 2x4 studs, lath & plaster interior*

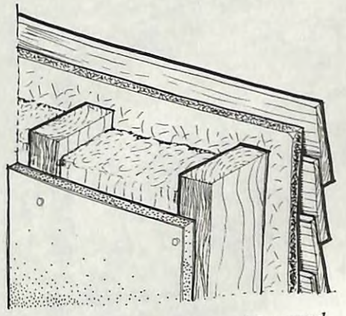


Figure 3: *Type 3 wall assembly: wood siding on non-impregnated felt building paper, ½" fiberboard on 2x4 studs, standard interior gypsum board*

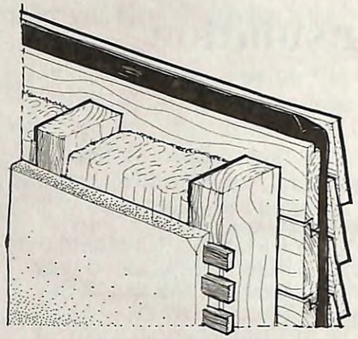


Figure 4: *Type 4 wall assembly: wood siding over non-impregnated building paper, 1x4 or 1x6 sheathing boards on 2x4 studs. Lath & plaster on interior.*

5. New houses, one or two years old which had extensive peeling and blistering paint, and cupping and splitting siding primarily on the exterior of the south and west elevations.

Field investigations revealed that in general, in each of the cases, moisture was present or there was visible evidence that moisture had been present between the horizontal lapps of the exterior siding and/or between the siding and the sheathing where sheathing was present. In each of the cases the cavity and insulation was dry, regardless of the type of insulation used, cellulose, fibreglass or foam.

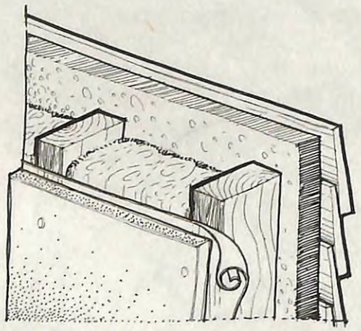


Figure 5: *Type 5 wall assembly: wood siding directly on foil faced isocyanurate or extruded polystyrene insulating sheathing, on 2x6 studs, 4 or 6 mil polyethylene under ½" gypsum board interior.*

In Type 1 (peeling and blistering paint on the exterior of the south and west walls) the moisture problems were typically the worst. Portions of nails in the sheathing and the siding were often seriously rusted, the exterior surface of the fibreboard sheathing was often saturated along with the back side of the siding, or it was damp, mildewed or rotting. The interior surfaces of the fibreboard (at the insulation/sheathing face) were typically dry.

In Type 2 (peeling paint on the interior of the south facing walls) there was no sheathing present and the amount of moisture between the laps was often negligible and intermittent.

In Type 3 (minor peeling and blistering paint on the exterior of the north and east walls) the symptoms were similar to those described for category 1, only to a much lesser extent.

In Type 4 (no problems) only traces of moisture were found between the horizontal lapps. Rough sawn board sheathing did not have any traces of moisture.

In Type 5 (new homes with peeling, blistering paint and cupping and splitting siding on the exterior of the south and west walls), the moisture was concentrated at the interface formed by the back of the siding and exterior surface of the insulating sheathing. The exterior or front surfaces of the siding were often dry, but the back surfaces were wet, damp or saturated, or there were indications that they once were. The wall cavities and insulation was dry.

What was happening?

It was not possible to determine definitively whether the source of moisture was primarily external, or primarily internal or a combination of both. Both exterior and interior sources of moisture are each capable of producing the problems. Interior moisture sources are usually blamed. Eliminating interior moisture getting into the wall alone cannot be relied on to eliminate the paint and siding problems.

External moisture (rain water or surface condensation dew) penetrates the siding under the influence of wind and capillary forces which can pull surface water on the siding up between the horizontal lapps of the siding. The moisture can then migrate towards both the exterior and interior.

Moisture is driven from the siding/building paper face into the siding (typically at night), when the siding is the coldest component of the wall. The siding will likely not give off moisture to the exterior, but rather absorb moisture, both from the exterior and from the siding/building paper interface. This happens because of the unique property of wood which absorbs moisture according to the "relative humidity" as opposed to the actual vapour pressure.

There may not be much moisture present in the outside but the little moisture that is present may be close to the total amount of moisture the air can hold at that particular temperature (ie, a high relative humidity). The wood siding "sees" this high relative humidity and either draws moisture from the exterior and/or does not give off moisture to the exterior. This phenomenon may be enhanced, when buildings are exposed, to a clear night sky so the siding can actually be at a much lower temperature than ambient conditions.

During the day, the sun dries the wet exterior surfaces of the siding by evaporation to the outside as well as driving moisture into the wall by raising the surface temperature of the exterior cladding to set up both a temperature difference and a vapour pressure difference acting inward. How far the moisture goes into the wall depends on the construction of the wall, especially the vapour permeability of components, their moisture storage capacity and most significantly the temperature of each of these components.

Condensation happens where there is a change of permeance, such as at the interface of two different materials where these materials are below the dew point temperature. How much moisture accumulates will depend on the potential for evaporation at that point. The colder the interfaces between materials become, the more moisture accumulate.

In a typical wall, interior moisture will first move to the cavity/sheathing interface, and from there, depending on the permeability and moisture storage properties of the sheathing, move through and/or around the sheathing to the building paper/sheathing and siding/building paper interfaces where it may accumulate.

The more insulation that is added to a wall, the colder the faces between materials at the exterior of a wall, (the insulation/sheathing interface, the sheathing/building paper interface and building paper/siding interface). Adding insulation to a wall cavity reduces the "drying potential" of the wall components to the exterior of the insulation and as such increases the rate of moisture build-up at the interfaces of these components.

Type 1

In the type 1 cases moisture had always been finding its way into the walls from both inside and outside. Regardless of which source, the moisture would accumulate at the siding/building paper interface.

After the addition of insulation, the drying potential was reduced enough to increase the moisture accumulation at the siding/building paper interface to eventually cause peeling and blistering paint problems.

But why were these problems concentrated and/or more severe on the south and west elevations? The answer lies in the effect of solar radiation. The sun served to dry the exterior surface of the siding through surface evaporation. This is of course inhibited by the relative impermeability of the paint film itself and enhanced by the buoyancy effects of warm, heated air washing up the exterior surface of the wood siding.

Secondly, solar radiation increased the temperature of the siding relative to the building components towards the interior of the wall, thus creating a vapour pressure gradient driving moisture into the wall. It also increased the stress on the paint surface to the point it separated from the wood siding.

Type 2

In type 2 cases, where paint peeled on the interior surfaces of south walls, moisture had always been finding its way to back of the wood siding from both inside and outside. In these cases there is no building paper and no sheathing. This had little effect before the addition of insulation.

After the addition of cavity insulation, the drying potential at the siding/insulation interface was reduced, not enough to create problems on the exterior siding, but sufficient to allow moisture accumulation to occur. Solar radiation now drove the accumulated moisture from the back side of the siding right through the wall to the interior finish, the plaster and lath.

Had here been a polyethylene vapour diffusion retarder behind the plaster and lath interior finish, interior paint problems would not have occurred, as the moisture would have accumulated on the cavity side of the polyethylene film and subsequently migrated to exterior again after the vapour pressure gradient reversed at night.

Type 3

In the type 3 cases where minor peeling and blistering paint was occurring on the north and east elevations, the mechanisms again are identical to the category 1 cases.

On the north and to a certain extent on the east exposures, there is less solar radiation and to move moisture inward, away from the siding/building paper interface, as sufficient moisture accumulated to cause minor peeling and blistering paint problems.

Type 4

In the type 4 cases the houses had no siding or paint problems after the addition of cavity insulation due to the greater permeability and moisture storage capacity the non-impregnated building paper and rough sawn wood sheathing, as well as the greater air leakage of the board sheathing compared to the siding/building paper/sheathing combinations described in types 1, 2 and 3. When moisture accumulated at the siding/building interface it can easily migrate back into the wall and be stored in the wood.

Type 5

In the type 5 cases, where extensive peeling, blistering paint, cupping and splitting of siding occurs, the culprit is exterior moisture combined with the impermeability of the insulating sheathing. The insulating properties of the insulating sheathing also have an effect on the siding problems, but are much less a factor than the impermeability.

The wood siding becomes wet as a result of rain and capillary effects. Moisture accumulates on the back of the siding, and solar radiation drives the moisture into the wall. The impermeability of foil-faced isocyanurate and extruded polystyrene insulating sheathings prevents the moisture from migrating inward This leads to wetting of the rear surfaces of the siding. Solar radiation leads to uneven drying as the front surfaces of the siding are dry and back surfaces are wet. The paint and the wood sidings are unable to accommodate the stress imposed, so failure results.

The problems described happened as a result of a reduction in the "drying potential" of the exterior portion of each of the wall systems. The reduction was precipitated by the addition of cavity insulation in the first four types of cases, and the addition of insulating sheathing in the fifth category.

"Why do there seem to be fewer problems associated with batt insulations such as fibreglass and/or mineral wool?" The answer may lie, in considering the factors that influence the "drying potential". These include:

1. vapour pressure differentials between material interfaces;
2. the geometry of the wall components and how it effects the drying of wall components through air circulation, drainage and capillarity;

3. Permeability and moisture storage capacity of the wall system components.
4. Air movement within and/or through the wall system; and
5. solar radiation.

Blown or sprayed cavity insulations reduce air movement within a wall cavity by reducing the through-flow of air (infiltration/exfiltration) as well as the secondary effect of convective loops compared to batt insulations. It is ironic that because these blown or sprayed cavity insulations may be "better" than batt insulations, their use could lead to more siding and paint failures because they reduce the "drying potential" of the siding/building paper/sheathing interfaces more than batt insulations.

In addition, since the blown or sprayed insulations reduce infiltration/exfiltration, their use often results in higher background moisture levels within the houses themselves as the interior moisture dilution effect of air change is reduced.

What can be done to avoid these problems?

Not to insulate obviously is not practical.

One of the most effective strategies for compensating for the drying reduction in potential that insulations provide is to increase the opportunity for drying by manipulating the geometry of the siding/building paper interface to promote drying of components by evaporation, air circulation, drainage as well as providing a capillary break. This can be done in several ways:

1. In new construction, install wood sidings on furring strips, thus providing an air space immediately behind the siding. This promotes drying of the siding by air circulation, facilitating the drainage of condensed water as well as providing a capillary break. This air space is critical when using sheathings which are impermeable and/or have no moisture storage capability (ie. foil-faced isocyanuates, extruded polystrenes).

2. Installing plastic wedges to separate the laps of sidings in retrofit situations after blown insulations are installed in wall cavities. The separation of the siding laps facilitates drainage and drying as well as providing a capillary break. It is important to install the wedges at each stud where the siding is nailed to provide a continuous gap between each piece of siding and not between the studs as it often suggested by the manufacturers of the wedges.

3. Double nailing of siding with "round-headed" nails as was the traditional practice many years ago. The protrusions of the round heads provide a continuous gap at the laps of horizontal siding which promotes the

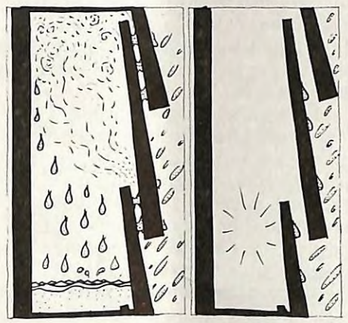


Figure 6: *To avoid problems walls must be able to dry out*

drainage of water, drying via air circulation as well as providing a capillary break.

The installation of small vents through siding sheathing (as is commonly recommended), is a potential formula for disaster. These vents do not increase the drying potential of the wall system, but rather serve to increase wall moisture problems by increasing rain penetration, and/or promoting air leakage.

The practice of "back-priming" of siding has been recommended as one technique to reduce paint and siding problems. This reduces the amount of moisture absorbed by the back of the siding by capillarity (the paint fills the capillary pores in the wood) and vapour diffusion/relative humidity. It does not eliminate the problems, but reduces their magnitude. To be completely effective, the practice should be coupled with an air space behind the siding.

The choice of "vapour permeable" paints, such as latex based exterior pains as an exterior finish helps in reducing peeling paint/siding problems. However, there currently is no paint which that is sufficiently permeable, flexible and durable to resist the new stresses imposed on wood sidings as a result of insulation induced reductions in drying potential.

The use of wedges to alleviate the problems described have been successful. Their use has not lead to insects using the openings created to build nests, as had been the concern. The moisture reduction makes the siding less attractive to these critters

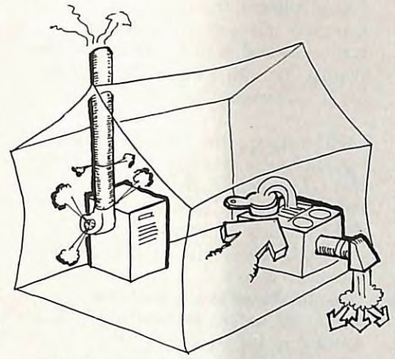
"Drying Potential" reductions from insulation installation can be compensated for by manipulating the geometry at the interior siding surface in order to facilitate drainage, drying and capillarity reduction.

Retrofit cavity insulation should be installed only after considering the effects of "drying potential" reduction and after compensation strategies, if necessary, have been implemented.

The use of insulating sheathings is highly desirable from the perspective of increasing the drying potential of wall cavities to reduce moisture problems in the wall. However, the use of insulating sheathing must also be coupled with strategies to compensate for the drying potential reduction of the exterior siding due to the impermeability and negligible moisture storage properties of the insulating sheathings.

House Depressurization Limits for Mid-Efficiency Gas-Fired Furnaces

Sebastian Moffatt *Peter Moffatt*



It has been widely assumed that mid-efficiency or induced-draft gas furnaces can tolerate moderate levels of house depressurization, without suffering from the pressure-induced spillage problems that have plagued conventional natural draft furnaces. On this basis, housing authorities have increasingly promoted mid-efficiency furnaces as the most practical solution to avoiding chimney backdrafting and spillage problems, especially in tighter-built, mechanically-ventilated housing.

As new codes and standards for ventilation and indoor air quality encourage mechanical ventilation systems in housing, many of which are likely to be exhaust only, the transition to mid-efficiency furnaces is likely to accelerate. These are often the most convenient and cost effective way for builders to avoid onerous requirements for large make-up air supply systems with expensive controls and tempering devices.

However, frequent or continuous house depressurization is becoming a common characteristic of Canadian housing stock that is placing exceptional demands on chimney performance.

Mid-efficiency furnaces were originally designed for energy efficiency only. Relying on these appliances to prevent combustion gas spillage has been expedient, but no research has been done to establish their performance in depressurized houses. Instead, assumptions have been made pressure limits based primarily on experience with natural draft furnaces.

House depressurization limits

The maximum safe level of house depressurization for a particular appliance and chimney design is referred to as the House Depressurization Limit (HDL). When a house exceeds the HDL, the potential exists for prolonged start-up spillage or continuous spillage or backdrafting whenever the furnace operates.

For a house with a natural-draft gas furnace, the HDL is approximately 5 Pascals (although this could vary by 1 or 2 Pascals, depending on the chimney height and whether it is insulated or located on the outside wall). When such a house is depressurized by more than 5 Pascals, the chimney may backdraft under stand-by conditions. Upon firing, the furnace is unable to reverse the backdraft and establish proper venting. Instead, all the combustion gases spill indoors through the dilution air opening of the furnace for as long as the furnace operates.

Because mid-efficiency gas furnaces incorporate an induced-draft fan, it has been assumed that the appliance is always capable of establishing proper venting on start-up. The HDL for mid-efficiency furnaces is typically assumed to be close to the minimum draft that is likely to exist in a hot chimney - somewhere between 20 and 30 Pascals. However, most mid-efficiency gas furnaces are not intended to pressurize the flue, they are vented into a natural draft chimney. Only those units designed for side wall venting are designed or certified to pressurize the flue.

Problems can happen at relatively low depressurization levels. In one experimental R-2000 house it was discovered that indoor/outdoor pressure differentials of 9 Pascals were enough to cause continuous combustion gas spillage from a side-wall vented, induced-draft furnace. Reasons for combustion gas spillage in the house were complex and included manufacturing defects, poor installation practices, and an apparent design flaw in the induced-draft fan assembly.

What was tested

Because there has been no research done on house depressurization limits for houses with induced draft furnaces, Sheltair Scientific was commissioned to do some field tests.

Five mid-efficiency furnaces were tested to establish their susceptibility to pressure-induced spillage. Each furnace was of different manufacture, and was tested as found in randomly selected Vancouver houses. Four of the five furnaces were spilling combustion gases under normal operating conditions - without house depressurization. This was primarily due to the poor design of the induced-draft fan housing.

An effort was made to locate at least one example of every make of mid-efficiency furnace currently sold in Canada. In several cases (eg. Clair and York), the distributors had not yet sold any mid-efficiency furnaces in British Columbia, so not all units were included in the study.

Each mid-efficiency furnace was treated as part of a system as installed, including the house, chimney, and the appliance. There was no attempt to isolate and separately test each component of these systems.

The testing was done at the end of the heating season when weather conditions were mild and calm (i.e. worse case conditions for the venting

of combustion appliances). All tests were carried out when winds were below 10 km/hr and indoor/outdoor temperature differences less than 16°C but more than 4°C.

Seven questions were asked before establishing depressurization limits.

1. Do combustion gases spill indoors under normal operating conditions? Potential gas spillage sources can be joints and elbows in the vent connections; at the flue collar; in the furnace around the fan housing; and the draft hood of a domestic hot water heater (if commonly vented).
2. Does the spillage quantity increase with increases in house depressurization?

3. What is the shut down response time for the furnace when major spillage occurs at the vent safety shut-off switch?

4. Is there a house depressurization level at which the appliance/chimney system fails to establish an updraft?

5. If a domestic hot water heater shares the same flue as the furnace, what is the pressure at which the system fails to establish an up-draft?

6. With the flue pipe completely blocked, how long does it take the appliance to shut down?

7. Does house depressurization affect the combustion efficiency of an induced draft appliance?

Manufacturers indicated that mid-efficiency furnaces were designed to operate under atmospheric pressures and have never been tested at the factory or at the Canadian Gas Association (CGA) for the purpose of establishing house depressurization limits. Although manufacturers recognize that a significant market has been created for mid-efficiency furnaces because the appliances are assumed to provide safer venting in airtight housing, they are not prepared to guarantee safe performance at any amount of house depressurization.

Induced draft furnaces fall into two categories, depending on how they can be vented. One category is approved for horizontal venting through a side wall of a house, the second is approved only for venting into a vertical natural draft chimney and can share a flue with a naturally aspirated gas-fired domestic hot water heater.

Furnaces approved for horizontal venting have a pressure proving switch that shuts the furnace off if the induced draft fan does not operate or if the chimney is plugged for any reason. Under normal operation the furnace is expected to pressurize the flue when there is a wind blowing against the wall termination, or when starting up against a cold flue. Manufacturers' installation literature requires that the flue be sealed with high temperature silicone or flue tape to prevent spillage of combustion gases.

The current design of most mid-efficiency furnaces does not appear to be appropriate for use in airtight housing where frequent or continuous house depressurization is a possibility.

Furnaces approved for connection to a natural draft chimney must carefully control the flow of combustion gases so that the flue is not over-pressurized. The control is achieved by means of an opening and a pressure relief box at the induced draft fan outlet. A pressure proving switch measures the pressure differential across the opening, and if no significant pressure differential exists, (as may happen if the fan is not operating or because a plugged chimney is preventing flow through the orifice) the appliance shuts down. These units are also equipped with a thermally activated vent safety shut-off switch (or "spillage switch") that is designed to shut down the appliance within 5 minutes if there is continuous spillage out of the spillage port due to blockage in the flue.

CGA certification does not specifically address operation in a depressurized house. The primary concerns are with the production of carbon monoxide and with combustion gas spillage caused by the pressurization of the flue connector. Apparently no inspection is specified for spillage caused by faulty design.

To test the spillage switch in accordance with the CGA standard, enough restriction is placed downstream of the induced draft fan to create 12.5 Pascals of static pressure. Under this condition the furnace must shut down within 5 minutes. An assumption is made that a domestic water heater can safely vent into a shared flue connector if the furnace does not positively pressurize the vent by more than 12.5 Pascals.

Vent Safety Shut-Off switches consist of simple bi-metallic discs usually with manual resets. The 5 minute delay is about the same duration as the normal operating time of a furnace and appears to be too long to be effective. The spillage switch design was a compromise between practicality and safety. The industry did not want appliances shutting down when occupants were away, (possibly causing major freeze damage to the house). The industry also wanted to prevent nuisance calls for distributors and installers. Hence the 5 minute delay.

What was found?

The current design of most mid-efficiency furnaces does not appear to be appropriate for use in airtight housing where frequent or continuous house depressurization is a possibility. Only one of the five furnaces models tested performed well in all situations. Sealed combustion furnaces may be more appropriate.

Manufacturers of mid-efficiency furnaces should be requested to consider redesign of their appliance so that it is gas tight and suitable for use in houses susceptible to depressurization.

Canadian Gas Association should consider incorporation of a test for house or room depressurization limits as part of the standard testing of mid-efficiency furnaces.

Tests need to be conducted to quantify the amount of spillage taking place through the fan housing of the draft inducing fan assembly under normal operating conditions.

Installers of side-wall vented mid-efficiency furnaces should be required to do a commissioning test after installation to test the tightness of the venting system and the safety shut-off. The commissioning tests should entail the blocking of the flue at the wall outlet to confirm that the appliance will actually shut down.

The Vent Failure Sut-off Switch on mid-efficiency furnaces should be redesigned to serve a useful purpose. Where possible the exit port should be redesigned to minimize the quantities of spillage, and time delay should be shortened to a more reasonable time period (e.g. 3 minutes).

The study suggests that instead of more testing of specific models of furnaces, standards writing groups and housing regulatory groups adopt the following House Depressurization Limits (HDL's) for mid-efficiency appliances:

1) 5 Pa Where there is no evidence of flue sealing
or
if the furnace shares a flue with natural draft appliance

2) 10 Pa Where there is clear evidence of flue sealing
and
the flue is single, or shared with an appliance

3) 20 Pa Where the furnace is side vented
and
the furnace shuts down when the outlet is blocked

Although there are exceptions, induced draft furnaces should not be installed in houses designed to operate under continuous depressurization.

From "House Depressurization limits for Mid efficiency Gas-Fired Furnaces", a paper presented at Renewables: A clean Energy Solution, the 15th Annual Conference of the Solar Energy Society of Canada, (Penticton, June 1989).

House	Furnace	Spillage with no depressurization	Spillage during depressurization	Time delay for vent safety shut-off switch	Ability to establish proper venting	Input of shared dhw
1	Amana Air Command	none	Spillage from chimney at 25 Pa & from safety port @ 30 Pa	2 minutes at 30 Pa	performs well up to 30 Pa	No DWH heater present
2	Carrier Bryant	Continuous small amounts around induced draft fan housing	Quantities around fan housing increased. Spills from safety port at 20 Pa	No effect up to 20 Pa (home could not be depressurized above 20 Pa)	Could not establish draft at 15 Pa	Spills via shared flue at 10 Pa
3	ICG Ultimate II	Continually at induced draft fan housing, fan outlet, and around pressure reading box	Slight increase with depressurization. Spillage from chimney joints at 33 Pa, and from safety port at 40 Pa	32 seconds at 50 Pa.	Required 55 seconds to establish draft at 22.5 Pa	Spills via shared flue at 15 Pa
4	Airco Turbo 8300	Continually at fan axle, flue collar and fan housing	Spills large quantities from axle hole with minor house depressurization.	No affect up to 50 Pa.	Performs well up to 50 Pa	No DHW heater present
5	Lennox Conservator 3	Continuously at collar above fan, at axle, bottom of fan housing and furnace connection with fan housing.	Quantity of spillage increases up to 15 Pa. and chimney spills in large quantities.	No switch present, and no shut-off even with major spillage occurring	Performs well up to 20 Pa	Spills via shared flue at 10 Pa

Chimney Performance

Six different chimney types and three chimney connector (flue pipe) designs were monitored at a test house in Ottawa. The objective was to evaluate the effects of chimney insulation and downsizing.

Tests were carried out on the six 26 foot (8-metre) chimneys in calm weather and near freezing conditions. The chimneys removed combustion gases from a 26 kw oil furnace run from a cold start while the house was slightly depressurization.

Three of the chimneys were 4 inch (100 mm) factory built; two were well insulated and one was a standard A-vent. The three other chimneys were a 7 inch (175 mm) A-vent, a 6 inch (150 mm) and a 6 1/4 inch (160 mm) rectangular clay flue masonry chimney.

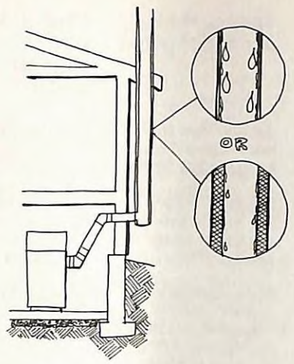
All 100 mm chimneys spilled combustion gases for excessive periods when the furnace was started, indicating the capacity was inadequate for the furnace. The larger chimneys had little start-up spillage. The 150 mm and 175 mm factory-built chimneys had ample flow capacity (they carried a 70% surplus of dilution air at steady state conditions).

The highly insulated chimney performed much better than others as it was able to maintain higher temperatures and prevent condensation of the flue gasses.

Where cycle periods are less than 8 minutes (a typical furnace cycle), condensation may affect even the better insulated flues. Better insulated chimneys and chimney connectors reduce the quantity and duration of chimney condensation associated with furnace cycling. The reduced condensation results in higher chimney temperatures being achieved quicker, thus improving performance.

In the case of masonry flues, the larger thermal mass of the flue means that more heat goes into warming up the flue before the steady state temperature conditions are achieved.

Insulation R values are derived at steady state conditions. In the case of



flues, the changing temperature conditions mean that the effective R-value of the flue changes until such time as steady conditions are developed. All chimney types developed their R-values at stability, but in the case of short operating cycles, the flues may not achieve steady state conditions before the furnace shuts off. As a result the effective R-values may be lower in those situations.

Infiltration into chimneys (air leakage through joints) can lower the effective insulation value by as much as 33%, and thus the chimney performance.

From a cold start all chimneys formed a wall condensate. Better insulated chimneys had shorter condensation periods and attained operating conditions much faster. Both A-vent chimneys barely managed to get rid of condensation after 8 minutes. In the uninsulated exterior masonry chimney, condensation lasted for periods exceeding 15 minutes.

The 100-mm insulated chimney connector helped maintain a 10° higher temperature in 100-mm chimneys, thus slightly improving operating conditions and reducing the condensation period.

"Testing of Various Chimneys and Chimney Connectors at the CMHC owned Armstrong House" prepared by Charles LeMay and Gary O'Connor for CMHC.

Round Pegs in Square holes

Design and attention to detail to produce quality housing is important. The R-2000 program in it's builder education courses has stressed the value of preplanning. We have seen much progress on the job site. Attention to detail includes careful design and layout of heating and ventilation ducts, and the sealing of all joints when they are installed.

Fewer plumbers and electricians arrive on the job site with chain saws and 3" drills when they only need a ½" hole. So why is it that heating contractors insist on putting a 4" diameter duct in a 3½" wall?

I've recently encountered the situation in a custom house in Vancouver. We had prepared a layout for the heating and ventilation system.

The heating contractor came in, and insisted on doing his own thing or nothing. This involved using 4" ducts (almost exclusively). Evidently, he didn't want to bother changing the size of ducts, no matter the consequences. This led to the absurd situation of banks of ducts filling entire joist spaces. I am convinced much more sheet metal than was used was needed.

In some locations these had to run through 2 x 4 frame walls, which as we know are not really 4" but 3-½" (but the ducts are true).

Because of the hot construction market in Vancouver, the contractor felt obligated to go along with the heating contractor. But as oval ducting is not standard, 4" diameter ducts must be squashed on site (oval elbows anyone?). The squashing of ducts on site could add extra turbulence to the airflow if it's not done properly.

Somehow, I think there's something wrong with this kind of approach. Isn't it time that the sheet metal trades be asked to do the right thing or nothing?

Richard Kadulski

Letter to the Editor

Sir,

Solplan Review is my best way of keeping current on Canadian construction issues and matters of moment.

Your comprehensive article on CFC Use in Buildings (**Solplan Review** No. 29) was very interesting and renewed my puzzlement about ozone. This stems from the facts (or apparent facts) that ozone is regarded as a pollutant in the lower atmosphere - yet it is essential in the upper atmosphere to block ultra violet radiation.

An item in our local paper came as several surprises to me. I hadn't learned from any other sources that the antarctic ozone "hole" vacillates "open and shut".

I also had never heard that ozone is measured in "Dobson Units".

Perhaps **Solplan Review** has done as thorough a review on ozone as you've just done on CFC's and I've failed to note it. If not, it'd be a very useful and relevant topic. It might well include all sources of ozone from lighting to electric cars.

E.E. Robertson
Winnipeg, MB

Thanks for your comments. We haven't done anything on ozone yet. That ozone measurements have their own rating scale is news to us also. Thanks for your information. ED

New Super Window

In recent years, the window industry has focused on selective coatings and gas-filling to achieve higher centre-of-glass R-values.

The Southwall Corporation has taken a different path. They are the developer of thin films with selective coatings that are incorporated in sealed glass units, marketed under the **Heat Mirror** name.

Southwall has now announced the development of a new high-performance insulating glass product designed for use in residential windows. It is called the **Superglass** system, and is claimed to deliver insulation values up to R-8. It features an insulating spacer, double film and a gas filling.

It requires manufacturing equipment and techniques that are different from those used in making insulating glass equipped with Heat Mirror films so at the moment **Superglass** is only available through Hurd Millwork windows in the USA.

The insulation value of the best gas-filled low-e coated glass units presently on the market approaches R-5 for triple glazed units.

Radon Handbook

The NAHB National Research Centre has been involved in the study of radon since the early 1980's. They have worked with the U.S. Environmental Protection Agency to develop and test radon reduction techniques in new and older homes. Many of these methods were included in a joint EPA-Research Centre publication: **Radon Reduction in New Construction: An Interim Guide.**

A number of significant changes have occurred in the radon field in the three years since this guide was introduced. As a result, the NAHB have developed the **Radon Handbook for the Building Industry.**

The handbook features background information on radon as an indoor air pollutant, radon-resistant construction techniques, builder liability issues, and suggested contract language. This easy-to-use handbook provides the essential information needed to build radon-resistant homes without the extraneous information contained in most documents.

Copies ($10.00 per including postage and handling) are available from:
Radon Handbook
NAHB National Research Centre
400 Prince George's Boulevard
Upper Marlboro, MD 20772-8731
Tel: (800) 638-8556
(301) 249-4000

Frozen HRV's

We have heard that a recent study of energy efficient homes found that the cores of some high efficiency HRV's were solid blocks of ice. The frozen core obviously meant that the defrost mechanism did not work, so in those homes the HRV units were not doing the job they were supposed to.

From what we hear, this only affected one specific model of one manufacturer, and the cause has not been completely analyzed at this time.

Could this be caused by the hunt for the (theoretically) most efficient performance at the expense of practical field operation, or of extreme conditions encountered in the field?

We would be interested in hearing from our readers if any have come across this kind of problem.

ADA Builder Course

The air tight drywall approach (ADA) is a relatively new method that many builders and building inspectors are not yet familiar with.

A course has been prepared for CHBA-BC to provide material for builders and building inspectors on how to air seal new houses, stressing the air tight drywall approach (ADA).

The course covers building science to provide an understanding of why air sealing is necessary, what must be done and how it ties in to other components in the house. A site visit at the pre drywall stage (caulking, gasketing and sealing stage) is part of the course.

To verify adequate tightness, it is being proposed by CHBA-BC that houses not built R-2000 or Quality Plus Program meet a tightness of 2 ACH at 50 pascals as an acceptable alternative. (The testing to be done by trained airtightness testing technicians).

An illustrated manual has been prepared for the course. A pilot session was held in Victoria February 15, 1990.
Information:
CHBA-BC, 3700 Willingdon Ave.,
Burnaby, B.C. V5G 3H2
Tel: (604)-432-7112

Barrier-Free Design

Would you tell a prospective home buyer "You're not allowed in to see these show homes - there may be something for you down the street"? Sound far fetched? Would you believe it happens on a daily basis (and you're probably guilty too)?

We're not talking about discrimination based on colour, religion or family status. However, every day we are discriminating against thousands of people with physical disabilities. People with disabilities can't even enter most of our houses.

Those of us who are able bodied can't imagine what it would be like to be confined to a wheel chair, or even have a disability that makes walking difficult. If you have had the misfortune of being in a cast and had to hobble around with a crutch due to a sprained ankle or a broken foot will begin to realize some of the problems.

In the past we've locked up the disabled. Now we are becoming aware that is the wrong thing to do, and the disabled themselves are becoming more vocal.

So how big an issue is this? Statistics indicate that one in seven has some form of limited physical disability and would benefit from a more accessible environment. This does not include people over 65 whose mobility has been reduced by the aging process. The disabilities arise from a variety of sources: they could be genetic at birth; due to disease; or due to traffic, recreational or industrial accidents.

Design and construction for the disabled is more complex than just using wider doors and larger bathrooms with some grab bars. Proper design must also take into account all other features of a home, including consideration to access and hardware.

For those that have not been involved with design or construction for the disabled, there now is a resource centre that can provide services and expertise in the field of barrier-free design and construction.

The **barrier-free design centre** a non-profit charitable organization dedicated to making the built environments more accessible and usable by all people. It offers several services:

* consulting services: they will answer basic questions and direct where to get additional information needed for specific problems.
* Education: general awareness workshops and technical education programs for designers, contractors, building officials and others on issues related to barrier-free design.
* Information: a resource centre is operated featuring journals, articles, periodicals and other materials on barrier-free building materials.

The centre has just published a **Directory of Barrier-Free Building Products**. This is a no nonsense product database listing building products, a brief description, contact names and addresses. It does not give product specifications, but sources for further information.

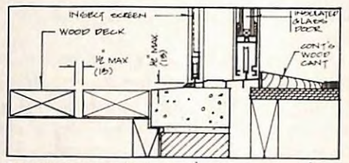
This reference book will be of value to designers or builders who are actively involved in work for the handicapped, and who must specify or source a wide range of products.

Those involved only with the occasional project may find it just as easy to refer to the directory in a library, or to contact the centre directly with the specific request for information.

A more valuable reference for all designers and builders who will face a project for the handicapped is **The Source Book: Architectural Guidelines for Barrier-Free Design.**

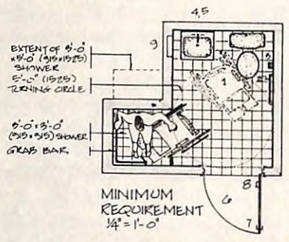
the barrier-free DESIGN CENTRE

REMOVING ARCHITECTURAL BARRIERS FOR ALL CANADIANS



This is a loose-leaf format manual that is easy to read and well organized. I highly recommend it.

The first section deals with the client needs: what to look for in assessing client needs.



Design options are discussed and solutions offered in a room by room analysis, starting from site planning and entrances, to corridors and hallways, to bathrooms, and living spaces.

Directory of Barrier-Free Building Products $49.95

The Source Book: Architectural Guidelines for Barrier-Free Design
$45.00

Information:
Barrier-Free Design Centre
2075 Bayview Ave.
Toronto, Ont. M4N 3M5
Tel: (416) 480-6000
FAX: (416) 480-6009

A Message from the TRC

Canadian Home Builders' Association

This issue marks the start of a three issue test period. During this period, CHBA's Technical Research Committee (TRC) has arranged for copies of **Solplan Review** to be sent to builder members of the Association.

CHBA takes seriously the need to communicate and disseminate important technical information. TRC has influenced the production of a number of useful publications including the advisory documents used in the CMHC/CHBA Builder Workshops and the CHBA Builder Manual. We believe this publication sets a new standard for publications for the industry. CHBA newsletters, Home Builder Magazine and the National Newspaper also focus on technical issues and help TRC get its message to CHBA members.

In the last issue of **Solplan Review** the publisher noted that for some CHBA locals, technical and other professional issues may fall behind social activities in terms of the interests of members. We believe that the CHBA must continue to give priority and profile to issues associated with housing quality such as research and development, work on codes and standards, and education and training. It is this work that enables the Association to play a leadership role as your voice on matters affecting this industry.

It is vital that the CHBA stick to what it does well - influencing government agencies and others that produce substantial publications and communicating the work of the TRC through association vehicles. **Solplan Review** is well respected within the industry and it provides useful information on technical developments and innovations which can benefit CHBA members.

Through the test period, CHBA builder members will be able to read about TRC new in **Solplan Review.** We will be asking for your input and judgement in due course. If successful, the TRC will investigate ways to expand the delivery of the newsletter to members.

Willis Graham
Chairman
Technical Research Committee

Regular readers need not fear; we haven't sold out. The terms for this arrangement is that the editorial integrity of Solplan Review will remain unchanged (but Solplan Review becomes available to a wider audience).

We will be reporting on the activities and research work that is being done with the involvement of the TRC in our usual fashion.

We started Solplan Review in 1985 because we saw there was no independent source to provide information and commentary on all aspects of building science and energy efficient construction for new and retrofit construction.

To maintain an independent position, we rely on the support of our readers, not like most other publications that live off advertising. We accept some ads but our main source of revenue is paid subscriptions. We hope we will gain your support.

Richard Kadulski, Publisher

What is the TRC?

The Technical Research Committee of the CHBA is the only group in Canada that brings together industry, government and academic agencies to discuss common issues, goals and activities in the home building industry. It is a clearing house for information on activities and developments in the field.

The committee is structured in three main groups, that aside from the management sub-committees include:

Research and Development: this group explores areas and topics for reactive and proactive research that may be done by industry and public sectors. The kinds of concerns that are being discussed at the moment include:

- **drywall discoloration:** Phase 1 was work that tried to identify the extent and nature of the problem. As conclusive answers have not been obtained, a more comprehensive, detailed scientific study to get to the root of the problem is being planned as phase 2.
- **Ventilation projects:** a series of studies are under way. These include a study to determine the impacts that CSA F326.1 (the draft residential ventilation standard) will have on housing. Others are looking at alternate cost effective ventilation strategies.
- **Moisture studies**: survey of moisture content in lumber available in the market, as well as moisture in attics.
- **Basement research**: studies to see how air infiltration/exfiltration happens. This is important for radon and soil gas control.

Codes and Standards: this group deals with changes to codes and standards that will have an impact on the housing industry. This provides feedback to this agencies.

Currently the major issues being dealt with by this committee include:

- **CSA F326.1** The draft Residential Ventilation Standard, and its impacts.
- **Mandatory Fire sprinklers**: a great deal of work has been done to provide a rebuttal to the lobby that has been promoting the mandatory use of sprinklers.

Technical Advice and Publications: This group is concerned with getting the message out to the building community about what is going on. They oversee activities such as preparing the **CHBA Builder's Notes** series, input on the **CMHC/CHBA Builder Workshops, Warranty Program** workshops, and publications and information activities of other industry and public bodies.

The TRC receives reports from the technical committees of each provincial Home Builder's Association. In this way everyone kept informed of activities in the provinces. This also gives a chance to identify likely problems that may be more serious, especially if the problem happens to show up in each region.

The drywall discoloration problem was identified this way. At first some thought it may have been a problem of one or two batches of product or an improper application. (Too often suppliers will try to convince you that is the case). However, when the same problem kept coming up, it quickly became evident that it was a more serious problem, and the TRC promote research into the problem.

Changes at IRC-Saskatoon

The Prairie Regional Station of the Institute for Research in Construction (the National Research Council) located in Saskatoon will be closed within the year, and current projects will be moved to Ottawa.

The closure of the Prairie Station is a significant change. Much of the understanding of how small buildings perform in cold climates has been developed in the Prairie station. It was gained by NRC staff as they responded to enquiries and solved problems encountered in real-life problems encountered on the prairies.

By being on the spot, away from the centralized bureaucracy of Ottawa, they were able to respond quickly, identify problems, and formulate plans for formal research efforts.

It is hard to understand how centralizing all work in one location is going to be more efficient, especially in a country with as many climatic and geographical regions as Canada has.

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In SOLPLAN REVIEW NO. 26 we carried an index to issues 1-24.

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Crawl Space Ventilation by *Richard Kadulski* Feb-Mar 1989 No. 25
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Wood-Electric Heating Systems Feb-Mar 1989 No. 25

Your Home, Your Health and Well Being: Book Review Aug-Sept 1989 No. 28

If you are missing any back issues, a limited quantity are still available at $4.00 per copy.

SOLPLAN REVIEW, Box 86627, North Vancouver, B.C. V7L 4L2

Let us know what you think of SOLPLAN REVIEW. What are we doing right? what are we doing wrong? How can we be more useful to you? Drop us a line.

ADVERTISEMENT

There's 'whispers' in the industry: Ode to a Grill

There's whispers in our industry
'Bout changes in technology.
But is it all true change or not?
It somehow seems we have forgot
That change should mean improvement to
What we now have and what we do.
To illustrate this basic fact
A product must replace what's lacked.

And products that we do have now
Must be applied correctly. How?
To ventilate efficiently,
Don't choose your grills haphazardly!

Exhaust with model VLK
For low restriction passageway.
There's just this one grill you install.
Exhaust from ceiling or from wall.
Misuse this model for supply?
Fresh air won't mix, it will drop by
Your feet to ventilate them well.
Is this the way to cure the smell?

The wall mount model VLR
(the most neglected grill by far)
Specifically supplies fresh air
When high-wall mounted with great care.

Misuse this grill type for exhaust?
Your customer will pay the cost!
Reduced airflow due to restriction
Keeps soggy olfs inside the kitchen.

The ceiling model VLI
Is not the only fresh supply.
Installed in ceiling properly,
Fresh air will mix transparently.
Misuse this grill type on the wall?
Onto the floor cold air will fall.
The CO_2 then builds up high
And settles in to occupy
The air that should be fresh and clean
Stays stale and stuffy. This is seen
To be the cause of headache's flare
In master bedrooms everywhere!

Of course for those whose systems run
With forced air heating, mostly done
Without the furnace fan run low.
This causes the fresh air to flow
In swirls that somehow soon forget
Where they were going and I'll bet
Effectiveness is surely lost
As if in permanent defrost.

If air were coloured beautifully
And drifted through homes lazily
Then maybe someday we would see
Two airstreams coloured fancifully.
And if fresh air were tinted green,
Delivered right it would be seen
To 'wash' the room from grill to door
To clean the air and not the floor.
And as this air moved further still
Towards the nearest exhaust grill
The air to murky brown would turn
And proper use of grills we'd learn.

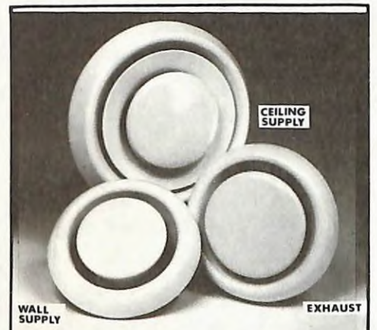
Though coloured air is never found
Good installations do abound.
But sadly it's the bad ones that
Can make this industry go flat.
And don't forget the owner's fate
Left in an undiluted state.

We want to see some changes made.
The industry can't masquerade
Behind some sluggish laws and rules.
We have the means! We have the tools!

One never knows what's coming next.
Our industry keeps most perplexed.
So if a copy comes along
To challenge what we've put to song.
We caution you to be aware:
Select the type of grill with care!

We trust the future holds in store
A trailer to the flaming core.
With baited breath we wait and will
Anticipate a barbecued grill.

"Charlie"



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3 different styles for 3 different jobs
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WHISPER Your home's indoor environment is an important part of your family's health and comfort.
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With our VARIquiet™ design, you'll forget your vanEE's there, even when it's working its hardest keeping your air fresh and clean. It's 'whisper' quiet.
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Household Energy Use

A recent report by the US Energy Information Administration (EIA), gives information on how USA households use energy. The study looked at a variety of randomly selected housing units of all types.

Average electrical consumption increased while household energy expenditures decreased. Overall, between 1984 and 1987 the price of gas decreased but electricity did not change.

Over one-half of all energy is used for space heating. In 1987, more energy was used for air conditioning and less for space and water heating than in 1984 (the difference was due partially to warmer weather). The decrease in space-heating consumption was more noticeable among households that heated with natural gas or electricity.

The amount of energy used for electrical appliances was greater in 1987 than in 1984, while less energy was used for natural gas appliances in 1987 than in 1984.

For housing units built after 1980, the average heating energy (Btu's per square foot and per heating degree-day) of all main space-heating fuels was significantly lower than in homes constructed in the 1950's and 1960's.

The elderly used more energy for space heating and less energy for water heating, air conditioning, and appliances than the non elderly.

This study reflects US patterns. No similar monitoring, as far as we know, is done in Canada (or at least, if it is being done, it is kept under wraps).

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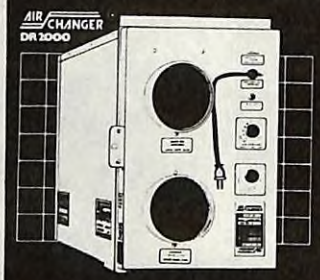

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